

**REMARKS**

Applicants find no rejection of claim 6. Applicants have amended claim 6 to include the all the limitations of the original claim 1 and the original intervening claim 5 from which claim 6 depended without adding any new claim limitations. Applicants respectfully request the Examiner provide an Examination of claim 6.

The Examiner rejected claims 1, 2 and 5-11 under 35 U.S.C. §102(b) as being unpatentable over Kobayashi (EP 0 886 308 A2).

The Examiner rejected claims 12-15 under 35 U.S.C. 103 as being unpatentable over Kobayashi (EP 0 886 308 A2).

The Examiner rejected claims 3 and 4 under 35 U.S.C. 103 as being unpatentable over Kobayashi (EP 0 886 308 A2) in view of McFadden (US 6610615B1).

Applicants respectfully traverse the §102(b) and §103 rejections with the following arguments.

35 USC § 102

Applicants point out that the limitation of claim 2 has been incorporated into amended claim 1 and claim 2 canceled.

The Examiner states that "Kobayashi does not refer to the method as a remote plasma nitridation, but rather states there is a problem with direct nitridation (column 2 lines 8-10, and describes a method as in the instant specification, thus the method taught by Kobayashi is remote nitridation even though not labeled as such)."

Kobayashi in column 2 lines 8-10 states "conventionally practiced direct oxynitridation using plasma has involved the problem that film quality is impaired to plasma damage." This statement does not mean Kobayashi is not practicing direct nitridation. One must turn to the specification of Kobayashi see what method Kobayashi is practicing and that is clearly illustrated in FIG. 10 and described in col. 10, lines 5 through 46 of Kobayashi and this is a direct nitridation process.

Applicants contend that claim 1, as amended, is not anticipated by Kobayashi because Kobayashi does not teach each and every feature of claim 1. As a first example Kobayashi does not teach "placing said substrate in a first chamber " and "generating a plasma in a second chamber" As a second example, Kobayashi does not teach "transferring nitridation species of said plasma from said second chamber to said first chamber."

First, there is only one chamber taught in Kobayashi. Second, the design of the Kobayashi nitridation apparatus necessarily requires formation of the plasma in the same chamber 101 as the substrate 102. Third, Kobayashi clearly indicates in col. 11, lines 22-26 that the plasma is generated between grid electrode 105 and substrate 102 which are in the same

chamber 101 as the substrate so the plasma of Kobayashi definitely cannot be generated "in a second chamber" as Applicants claim 1 requires.

Based on the preceding arguments, Applicants respectfully maintain that claim 1 is not unpatentable over Kobayashi and is in condition for allowance. Since claims 4-15 and 31-36 depend from claim 1, Applicants respectfully maintain that claims 4-15 and 31-36 are likewise in condition for allowance.

Applicants contend that claim 9 is not anticipated by Kobayashi because Kobayashi does not teach each and every feature of claim 9. For example Kobayashi does not teach "wherein said silicon oxynitride has a thickness of about 8 to 24 Å." The Examiner states that "Kobayashi does not teach a resultant silicon oxynitride layer of about 8-24 angstroms, but does teach the goal of the invention to have a resultant gate insulating film of 3 nm (30 angstroms) or less (column 1 lines 29-30), which is about 8-24 angstroms."

Applicants respectfully point out col. 1, lines 29-30 of Kobayashi states "For example, under the design rule of 0.1  $\mu\text{m}$  or less, gate insulating films must be as thin as 3 nm or less." First, this is a statement of a design guideline of the prior art and not a goal of the invention as the Examiner alleges. Second, there is no teaching in Kobayashi that his films meet this requirement. Thus Kobayashi can not be disclosing "wherein said silicon oxynitride has a thickness of about 8 to 24 Å."

Based on the preceding arguments, Applicants respectfully maintain that claim 9 is not unpatentable over Kobayashi and is in condition for allowance.

Applicants contend that claim 10 is not anticipated by Kobayashi because Kobayashi does not teach each and every feature of claim 10. For example Kobayashi does not teach "wherein said silicon oxynitride film contains between about 2 and 20 percent nitrogen." The Examiner states that Kobayashi teaches "the nitrogen content in the silicon oxynitride is between about 2-20 percent (11 %, column 9 line 34)."

Applicants respectfully point out that in col. 9, lines 19-23, referring to silicon dioxide film 5 states "the ratio of the number of nitrogen atoms contained in a surface region ranging from the surface to a depth of about 3 nm to the sum of the number of oxygen atoms contained in the region and the number of nitrogen atoms contained in the region was calculated as 11%." which is at odds with col. 9, line 34 which states "nitrogen content of 11% has revealed that an oxynitride film is formed at a surface region of the silicon dioxide film 5." Nitrogen atoms to nitrogen atoms+oxygen atoms ratio = 0.11 is not the same as a "content of 11% nitrogen" which is nitrogen atoms/all atoms = 0.11. This can be resolved by the fact that the second measurement technique, UPS samples only the surface of the oxynitride film, while the first measurement technique, XPS samples the whole thickness of the oxynitride film. Applicants claim "silicon oxynitride film contains between about 2 and 20 percent nitrogen" not "the surface content of the oxynitride film is between about 2-20 percent." And since it is not possible to calculate the percentage of nitrogen from the data given relative to the first technique, Kobayashi cannot be teaching "wherein said silicon oxynitride film contains between about 2 and 20 percent nitrogen." as the Examiner alleges.

Based on the preceding arguments, Applicants respectfully maintain that claim 10 is not unpatentable over Kobayashi and is in condition for allowance.

Applicants contend that claim 11 is not anticipated by Kobayashi because Kobayashi does not teach each and every feature of claim 11. For example Kobayashi does not teach "wherein the concentration of nitrogen in said silicon oxynitride layer is between about  $1E21$  and  $1E22$  atm/cm<sup>3</sup>." The Examiner states that Kobayashi teaches "the nitrogen content in the silicon oxynitride is between about  $1E21$  and  $1E22$  atm/cm<sup>3</sup> (11 %, column 9 line 34). This is the same concentration as listed in claim 10, only another way of describing the concentration."

Applicants repeat the arguments presented *supra* with regard to claim 10. Applicants point out that claim 10 is claiming a ratio of nitrogen to everything else while claim 11 is claiming an absolute quantity of nitrogen. Applicants further point out that  $1E22$  can very well be different from 11% depending upon the number of atoms of oxygen, nitrogen and silicon in a cubic centimeter of the oxynitride film.

Based on the preceding arguments, Applicants respectfully maintain that claim 11 is not unpatentable over Kobayashi and is in condition for allowance.

**35 USC § 103 Rejections**

Applicants contend that claim 13 is not obvious in view of Kobayashi because Kobayashi does not teach or suggest every feature of claim 13. For example, Kobayashi does not teach or suggest "wherein said silicon oxynitride layer has a thickness of about 0 to 35% greater than the thickness of said silicon dioxide layer." The Examiner states that "Kobayashi is silent as to the growth of the silicon oxynitride as to the silicon oxide layer, but teaches the resultant oxynitride layer cannot be made greater than a certain level (column 1 lines 56-57). Further, Kobayashi teaches the nitrogen to be incorporated into the silicon oxide film, but does not teach or suggest any thickness growth, only control of the resulting thickness. Thus without evidence to the contrary, Kobayashi suggests a growth of 0-35%."

Applicants respectfully point out that col. 1, lines 56-57 state "According to conventionally practiced thermal oxynitridation...however the method involved the problem that the thickness of a formed oxynitride film can not be made greater than a certain level." This is simply a statement of a problem in a method different from that of Kobayashi and can one cannot draw the prima facie conclusion that Kobayashi suggest any increase in thickness of the layer of silicon dioxide that incorporates nitrogen, particularly when the Examiner admits Kobayashi does not teach the limitation of claim 13. Applicants believe the Examiner has impermissibly shifted the burden of proof of prima facie obviousness to the Applicants.

Based on the preceding arguments, Applicants respectfully maintain that claim 13 is not unpatentable over Kobayashi and is in condition for allowance.

Applicants contend that claim 14 is not obvious in view of Kobayashi because Kobayashi does not teach or suggest every feature of claim 14. For example, Kobayashi does not teach or suggest "wherein the mean thickness of said silicon oxynitride layer varies by no more than about one-half angstrom sigma from a center to an edge of said substrate." The Examiner states that "Kobayashi is silent as to the thickness of the resulting layer's mean thickness varying by no more than 0.5 angstrom sigma from a center to an edge of the substrate. However, Kobayashi teaches the method (which is identical to that of the instant claims) for improved control of the resultant film. Thus without evidence to the contrary, the method of Kobayashi will result in the mean thickness varying by no more than 0.5 angstrom sigma from a center to an edge of the substrate."

First Applicants respectfully contend and have argued in reference to the 102 rejection of claim 1 that the method Kobayashi and the Applicants method are different. For example, Kobayashi uses a tungsten filament to generate a plasma in a single chamber right over the substrate, while Applicants generate a plasma by RF excitation in a chamber away from the chamber the substrate is in. Kobayashi heats the wafers with UV, Applicants use a thermal chuck. Any person of ordinary skill in the art would know that the apparatus of Kobayashi absolutely cannot duplicate the Applicants process

Second, the Examiner admits Kobayashi does not teach the limitation of Applicants claim 14 and has argued prima facie obviousness without compelling evidence and in doing so has impermissibly shifted the burden of proof of prima facie obviousness to the Applicants.

Based on the preceding arguments, Applicants respectfully maintain that claim 14 is not unpatentable over Kobayashi and is in condition for allowance.

Applicants contend that claim 15 is not obvious in view of Kobayashi because Kobayashi does not teach or suggest every feature of claim 15. For example, Kobayashi does not teach or suggest "wherein the nitrogen concentration of said silicon oxynitride layer varies by not more than about 25% from a center to an edge of said substrate." The Examiner states that "Kobayashi is silent as to the nitrogen concentration not varying by more than 25% from a center to an edge of the substrate. However, Kobayashi teaches the method (which is identical to that of the instant claims) for improved control of the resultant film. Also, Kobayashi teaches a concentration gradient only with the depth of the thickness, suggesting a uniform concentration along the surface. Thus without evidence to the contrary, the method of Kobayashi will result in the mean thickness varying by no more than 0.5 angstrom sigma from a center to an edge of the substrate."

First Applicants respectfully contend and have argued in reference to the 102 rejection of claim 1 that the method Kobayashi and the Applicants method are different. For example, Kobayashi uses a tungsten filament to generate a plasma in a single chamber right over the substrate, while Applicants generate a plasma by RF excitation in a chamber away from the chamber the substrate is in. Kobayashi heats the wafers with UV, Applicants use thermal chuck. The apparatus of Kobayashi absolutely cannot duplicate Applicants process

Second, the Examiner admits Kobayashi does not teach the limitation of Applicants claim 15 and has argued prima facie obviousness without compelling evidence and in doing so has impermissibly shifted the burden of proof of prima facie obviousness to the Applicants.

Based on the preceding arguments, Applicants respectfully maintain that claim 15 is not unpatentable over Kobayashi and is in condition for allowance.

As to claim 4, the Examiner states that Kobayashi teaches "using a nitrogen gas and an inert gas. The inert gas of Kobayashi is argon, neon, or the like (column 3 lines 23-24). The term "or the like" suggests other inert gasses may be used. McFadden teaches plasma nitridation of silicon oxide using an inert gas such as helium because the helium has a lower ionization energy (abstract). It would be obvious to one skilled in the requisite art at the time of the invention to modify Kobayashi by using helium as the inert gas as taught by McFadden because helium has a lower ionization energy (abstract)."

First, Applicants respectfully point out that McFadden teaches a parallel plate plasma process that excites the helium using RF coupling. Kobayashi use electron bombardment and the Examiner has presented no evidence that electron bombardment at the accelerating voltages levels taught by Kobayashi could excite helium.

Second, Applicants point out there is no teaching in Kobayashi that he is actually exciting the "inert" component of the gas mixtures. Only nitrogen containing species are taught to be part of the "plasma", while argon is taught only to "react." It is not inherent the reaction of inert gas be free radical driven, the reaction of inert gas could be thermally driven (the substrate is at 700 °C which supplies far more energy than the 53 volts taught by Kobayashi (col. 6, line 33)).

Therefore, Applicants respectfully contend that the Examiner has not supplied a reason for combining references that is found in the prior art.

Based on the preceding arguments, Applicants respectfully maintain that claim 4 is not unpatentable over Kobayashi in view of McFadden and is in condition for allowance.

**CONCLUSION**

Based on the preceding arguments, Applicants respectfully believe that all pending claims and the entire application meet the acceptance criteria for allowance and therefore request favorable action. If Examiner believes that anything further would be helpful to place the application in better condition for allowance, Applicants invite the Examiner to contact the Applicants' representative at the telephone number listed below. The Director is hereby authorized to charge and/or credit Deposit Account 09-0456.

Respectfully submitted,  
FOR:  
Burnham et al.

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